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Japanese Published Unexamined (Kokai) Patent Publication No. H2-87472; Publication Date: March 28, 1990; Application No. S63-240337; Application Date: September 26, 1988; Int. Cl.^{5}: H01M 4/88; Inventor(s): Hirotaka Nakagawa et al.; Applicant: Nippon Kokan K.K.; Japanese Title: Kotaidenkaishitsu-gata Nenryoudenchi-you Denkyoku no Seizou Houhou (Method for Production of Electrodes for Solid Electrolyte Fuel Cell)

Specification

1. Title of Invention

Method for Production of Electrodes for Solid Electrolyte Fuel Cell

2. Claim

A method for production of electrodes for a solid electrolyte fuel cell, characterized by the following steps in the production process: a step of forming a mask film onto one surface and the other surface of a solid electrolyte layer; a step of removing an undesired portion of the mask film; a step of vapor-depositing an electrode material onto the upper surface of the mask film by a laser PVD means; a step of removing the film; a step of forming a fuel electrode onto one surface of the solid electrolyte layer; a step of forming a pneumatic electrode onto the other surface.

3. Detailed Description of the Invention

[Field of Industrial Application]

This invention pertains to a producing method for a solid electrolyte fuel cell.

[Prior Art]

Unlike a thermal power generation and a nuclear power generation, a power generation by a fuel cell directly converts a chemical energy of a chemical fuel into an electrical energy by an electrochemical reaction. The efficiency in the power generation is higher, and there is no limitation on the size of the power generating facility.

Such a fuel cell initially employs a phosphoric acid solution fuel cell, thereafter having significantly improved the efficiency in the power generation and the cost from a fused alkali carbonate fuel cell to the solid electrolyte fuel cell.

As shown in Fig.5, a solid electrolyte fuel cell is comprised of the following components: a solid electrolyte layer 1 that is made from yttria stabilized zirconia [$(ZnO_2)Y_2O_3$] or the like; a fuel electrode 2 that is made from lanthanum cobaltite [$LaMnO_3(Sr)$] or the like and that is formed on one surface 1A of solid electrolyte layer 1 by a frame thermal spraying means; and a pneumatic electrode 3 that is made from nickel oxide (NiO) or the like and that is formed on the other surface 1B of solid electrolyte layer 1.

As in the solid electrolyte fuel cell as constituted as above, when the entire cell is heated to about 1000°C and when an outer circuit 4 is then connected between fuel electrode 2 and pneumatic electrode 3, current flows in outer circuit 4 as follows.

A fuel such as hydrogen (H_2) or carbon monoxide (CO) is supplied to fuel electrode 2. If H_2 is supplied to fuel electrode 2, H_2 reacts to oxygen ions in solid electrolyte layer 1 according to a formula 1 as indicated below to be robbed electrons (e^-). As a result, H_2 is converted into water (H_2O) to be discharged to the outside. At pneumatic electrode 3, O_2 and in the air and the aforementioned electrons that have passed

outer circuit 4 react to each other according to a formula 2 as indicated below to generate oxygen ions (O^{-}), which migrate toward fuel electrode 2 within solid electrolyte layer 1.

$$H_2 + O^{--} \longrightarrow H_2O + 2e^{-} \quad \cdots (1)$$
$$O_2 + 2e^{-} \longrightarrow O^{--} \quad \cdots (2)$$

The reaction of formula 1 occurs on one boundary surface between solid electrolyte layer 1 and fuel electrode 2, and the reaction of formula 2 the other boundary surface between solid electrolyte layer 1 and pneumatic electrode 3. Accordingly, fuel electrode 2 and pneumatic electrode 3 need to be a porous type so that a gas such as hydrogen or the like easily reaches one boundary surface and that a gas such as air easily reaches the other boundary surface, respectively. In addition to these requirements, electrodes 2 and 3 have to be extremely conductive so that electrons efficiently migrate.

[Problem(s) to Be Solved by the Invention]

However, prior art solid electrolyte fuel cell electrode as mentioned above has the following problems:

(1) In order to improve the efficiency of the power generation, the gas permeability of the electrodes should be improved. To obtain an improved efficiency, if the porosity of the electrodes is made to increase by adjusting the thermal spraying conditions, the strength of the electrode decreases, and the electrical resistance thereof increases to reduce the conductivity;

(2) As the thickness of the electrode cannot be made thinner, the electrode may be peeled due to a difference in the thermal expansion rates of the electrode to the solid electrolyte layer.

Based on the above problems, the purpose of the invention is to offer a method for production of solid electrolyte fuel cell electrodes having a high power generating efficiency and high strength, which are not easily peeled from a solid electrolyte layer.

[Measures for Solving the Problem]

The invention is characterized by the following steps in the production process: a step of forming a mask film onto one surface and the other surface of a solid electrolyte layer; a step of removing an undesired portion of the mask film; a step of vapor-depositing an electrode material onto the upper surface of the mask film by a laser PVD means; a step of removing the film; a step of forming a fuel electrode onto one surface of the solid electrolyte layer; a step of forming a pneumatic electrode onto the other surface.

A working example of a solid electrolyte fuel cell electrode of the invention is described next with reference to the drawings.

Fig.1 to Fig.5 illustrate the steps in the production process for the solid electrolyte fuel cell electrode of the invention.

First, metal mask films 5A and 5B at 10 to 20 μm as shown in Fig.2, which are made from Ni, Mo or the like, are formed onto one surface and the other surface of yttria stabilized zirconia solid electrolyte layer 1 at about 100 μm as shown in Fig.1.

Secondly, as shown in Fig.3, undesired portions of mask films 5A and 5B, more specifically, portions that do not form electrodes are removed.

Thirdly, as shown in Fig.4, electrode materials 6A and 6B are vapor-deposited onto the upper surfaces of mask films 5A and 5B, respectively, using a laser PVD. Electrode material 6A vapor-deposited on the upper surface of mask film 5A is made of

lanthanum cobaltite to be a fuel electrode, and electrode material 6B vapor-deposited on the upper surface of mask film 5B of nickel oxide to be a pneumatic electrode.

Finally, mask films 5A and 5B are removed using a solvent. By this means, as shown in Fig.5 and Fig.6 (A) to (C), fuel electrode 2 and pneumatic electrode 3 with desired patterns are formed on the upper surface of solid electrolyte layer 1. The thickness of electrodes 2 and 3 is 10 to 20 μm for both.

In the electrode patterns as illustrated in Fig.6 (A) to (C), the width of electrodes with stripes as shown in Fig.6 (A) and (B) and the diameter of an electrode with dots as shown in Fig.6 (C) can be controlled as needed within the range from 0.1 to 10 μm. The distance between the electrodes with stripes and the distance between the electrodes with dots can also be controlled as needed within the range from 0.1 to 10 μm.

Both side surfaces of the electrodes with stripes and dots are preferably formed into projections and recesses so as to accelerate the electrolyte reaction to solid electrolyte layer 1.

Advantageous Effect of the Invention

As described above, the invention brings various advantages as below. The films of the electrodes become thinner by forming the electrodes by the vapor deposition means, thereby preventing the peeling of the electrodes from the solid electrolyte layer due to a thermal expansion difference. The porosity of the electrodes is sufficiently increased without reducing the strength thereof, thereby improving the efficiency of the power generation.

4. Brief Description of the Invention

Fig.1 to Fig.5 are cross-sectional views illustrating the steps of the production process for a solid electrolyte fuel cell electrode of the invention. Fig.6 (A) to (C) are top views illustrating electrode patterns. Fig.7 illustrates the principle of a solid electrolyte fuel cell.

In the drawings, the following reference numbers indicate the following components:

1...Solid electrolyte layer

2...Fuel electrode

3...Pneumatic electrode

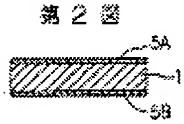
4...Outer circuit

5A and 5B...Mask films

6A and 6B...Electrode materials

第1図

第2図



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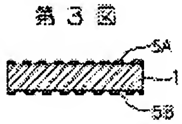
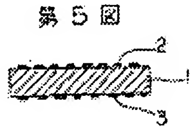


第4図

第5図



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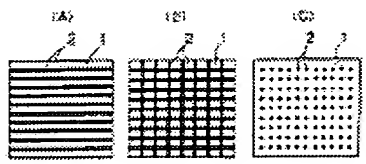

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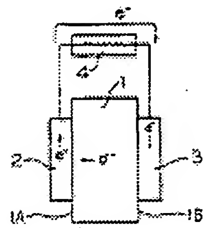

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